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ABSTRACT

To achieve a good teacher-pupil match, it is necessary (1) to predict the learning outcomes that will result when each student is instructed by each teacher, (2) to use the predicted performance to compute an Optimality Index for each teacher-pupil combination to indicate the quality of each combination toward maximizing learning for all students, and (3) to provide some indication of the extent to which concern about differential Teacher-Pupil Match (TPM) might make any difference. This project was designed to demonstrate the analytical and computational procedures required to produce Teacher-Pupil Match information to assist educational decision-makers in maximizing expected learner performance. This information can be used in conjunction with existing pupil assignment policies. The TPM information can be developed on a small computer system that is usually available in local school districts or regional educational service centers. (BW)

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# MATCHING PUPILS AND TEACHERS TO MAXIMIZE EXPECTED OUTCOMES

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## INTRODUCTION

Teachers and administrators meet at appropriate times during the school year to consider the important task of assigning students to teachers. These decision-makers consider both teacher characteristics (such as experience, special training, and ethnic background) and pupil information (such as sex, past academic performance, ethnic background, and behavior problems) in making teacher-pupil assignments to maximize instructional effectiveness. Without interfering with existing policies, principals and teachers may find it helpful to use additional information about expected future performance. As each pupil is considered for assignment to a teacher, it would be helpful to have a "quality" indicator for each possible teacher-pupil combination. The size of these "quality" indicators (numbers) would reflect to decision-makers the extent to which each particular teacher-pupil assignment can expect to maximize future achievement for the entire group of learners. These indicators would provide helpful guidelines to combine with existing procedures to improve learning outcomes of the school. Past developments by the U. S. Air Force with similar personnel matching problems can provide valuable techniques for matching teachers and pupils to improve future instructional outcomes. (Hendrix, Ward, Pina, Haney, 1979, Ward, Haney, Hendrix, Pina, 1978, Ward, 1959).

To achieve a good teacher-pupil match, it is necessary (1) to predict the learning outcomes that will result when each student is instructed by each teacher, (2) to use the predicted performance to compute an Optimality Index for each teacher-pupil combination to indicate the quality of each combination toward maximizing learning for all students, and (3) to provide some indication of the extent to which concern about

differential Teacher-Pupil Match (TPM) might make any difference.

The project described below was designed to demonstrate the analytical and computational procedures required to produce Teacher-Pupil Match information to assist educational decision-makers in maximizing expected learner performance. This information can be used in conjunction with existing pupil assignment policies. The TPM information can be developed on a small computer system that is usually available in local school districts or regional educational service centers.

PROCEDURE

To obtain the required decision-assisting indicators, the following steps are required:

1. Select a group of two or more teachers who are to be considered as instructors for a group of pupils; for example, three second-grade teachers who are to be assigned 25 students each from a group of 75.
2. For each teacher collect information from that teacher's students that allows for prediction of student performance at the end of the school year (such as reading or mathematics achievement) from data collected prior to beginning of the school year (such as previous reading or mathematics achievement tests, ethnic category, sex category, etc.).
3. Using the data collected in Step 2, compute for each teacher a multiple regression equation to predict performance at the end of instruction by the teacher from information available prior to instruction. These prediction equations may be computed using any multiple regression computer program. The computer program (referred to as Program A) used in this project was a FORTRAN program named LINEAR and was computed on the Control Data Cyber Computer at the University of Texas at Austin.
4. Using the separate prediction equations for each teacher, insert each pupil's predictor information into each teacher's equation and obtain

the expected future achievement for each student if they would be taught by each teacher. This array of predicted performance scores for each Teacher-Pupil Match is called the P matrix. The computer program (referred to as Program B) was written in BASIC and the data for this project was processed on a TRS-80 computer.

5. Assume that in the P matrix each student's data is arranged as a "row" and each teacher's data is arranged as a "column." Then compute (1) the mean predicted value for each pupil (row mean); (2) the mean predicted value for each teacher (column mean); and (3) the mean of all values in the P matrix (grand mean). This program (referred to as Program C) is written in BASIC for a TRS-80 computer.

Using the P matrix and the Pupil (row) Mean, Teacher (column) Mean, and Grand Mean compute for each teacher-pupil combination an array of Optimality Index values (called Matrix D) from the following relation:

$$D_{ij} = P_{ij} - \bar{P}_i - \bar{P}_j + \bar{\bar{P}}$$

Where

$D_{ij}$ = Optimality Index for pupil i with teacher j

$P_{ij}$ = Predicted performance for Pupil i with teacher j

$\bar{P}_i$ = Mean predicted performance of pupil i

$\bar{P}_j$ = Mean predicted performance of teacher j

$\bar{\bar{P}}$ = Mean predicted performance of all pupils with all teachers

A BASIC program (referred to as Program D) was used to compute matrix D on a TRS-80 computer. The value of the elements in D contain the information used to guide decision-makers in assigning teachers and students. A high value of $D_{ij}$ indicates that assigning pupil i to teacher j will tend to result in a high sum of predicted performance for <u>all</u> students.

6. To obtain an indication of the importance of paying attention to the matching of teachers with pupils (compared to random assignment) an analysis of variance program can be applied to the P matrix to determine

the proportion of performance variance accounted for by pupil differences, by teacher differences, and by the interaction among pupils and teachers. If there is a small amount of interaction, then it makes little difference which pupils are taught by which teachers. However, a large interaction indicates that it is important to make good teacher-pupil matches. The pupil differences, teacher differences and pupil-teacher interactions can be computed by standard procedures for the 2-way Analysis of Variance (ANOVA). The interaction sum of squares (S) can be easily computed from $S = \sum_{ij} (D_{ij})^2$.

7. If there is a large amount of interaction observed from an analysis of the predicted performance scores (P matrix), then the prediction equations can be used for future students who will be instructed by the same group of teachers. Evaluation of the Teacher-Pupil Match (TPM) process can be accomplished by comparison of the TPM students, (using the D matrix of Optimality Indexes) with a control group of students who were assigned to the teachers without using the Optimality Indexes.

The seven steps are summarized below:

1. Select a group of teachers and their pupils.
2. Collect student information to predict performance.
3. For each teacher compute a prediction equation for final student achievement.
4. For each student predict future performance from instruction by each teacher (P matrix).
5. From the P matrix compute the pupil mean (row mean), teacher mean (column mean) and grand mean; and then compute the Optimality Index values (D matrix).
6. Determine proportion of predicted performance variance due to pupils, teachers, and interaction.

7. If interaction is large, the prediction equation and optimality values can be used for future teacher-pupil matching and evaluation can be performed by using a control group for comparison to the TPM group.

## Description of Sample

To demonstrate the procedures, data was collected from one school in each of two different school systems. The two schools were designated School A and School B.

School A is located in a large United States metropolitan area with 14 separate school systems. The school system that School A is part of has an enrollment of about 35,000. The city is about 50 percent Hispanic and 40 percent Anglo, and 10 percent blacks. Student data came from three second grade classes. The campus selected for the study had about 475 students with Grades K-5. Thirty-one percent of the students were federally connected, with 37 percent receiving free and reduced lunch. There is about a 30 percent turnover rate for students each year. About 40 percent of the students are in some type of special program. Lower to middle class. In School A different analyses were performed for two measures of achievement--math and reading. In School B, analysis was performed only on reading achievement. The results of the seven steps already described in the Procedures section are presented for each of the three analyses.

School B is located in the southwestern part of the United States in a city of 250,000. The city's population is 60 percent Anglo and 40 percent Hispanic. Student data selected for this study came from three third grade classes. The campus used for the study, which had students eligible for Title I ESEA support, was 37 percent Hispanic and 63 percent Anglo.

## RESULTS

### School A - Mathematics

Step 1. Select teachers and pupils.

Data was collected from 42 second graders, each of whom was taught by one of three teachers.

Step 2. Collect information.

For each of the 42 second graders, the following information was collected:

Y: Posttest, Science Research Associates (SRA) Math Achievement Score obtained near the end of completion of second grade; reported in percentiles.

B: Sex Category of Pupil (Male or Female treated as binary information).

C: Membership by pupil in a special class (treated as binary information).

D: Pretest, SRA Math Achievement Score obtained near the end of completion of first grade; reported in percentiles.

F: Percent of time that a pupil is present in class.

T: Teacher Identification (1, 2, or 3).

Step 3. Compute prediction equations.

The three least-squares prediction equations are:

$P_1$ (predicted Math Posttest for Teacher 1) = 771.1649 - 12.8623 (B) + 23.7349 (C) + .5545 (D) - 7.7048 (E)

$P_2$ (predicted Math Posttest for Teacher 2) = 230.6578 + 16.5342 (B) - 20.0966 (C) + .8013 (D) - 2.2696 (E)

$P_3$ (predicted Math Posttest for Teacher 3) = -83.9826 - 5.0953 (B) + .7481 (C) + .5904 (D) + 1.1978 (E)

Where B = 1 if pupil is Male, 0 otherwise

C = 1 if pupil is in a special class, 0 otherwise

D = Math Pretest Achievement

E = Percent time attending class

For example, the predicted Math Achievement Scores for Student Number 10 are computed as follows:

Student Number 10 is a female (B=0), is in a special class (C=1), has Math Pretest Score of 5 (D=5), and attended 98 percent of the time (E=98).

$P_1$ (Teacher 1 for Student 10) = 771.1649 - 12.8623 (0) + 23.7349 (1) + .5545 (5) - 7.7048 (98) = 42.6

$P_2$ (Teacher 2 for Student 10) = 230.6578 + 16.5342 (0) - 20.0966 (1) + .8013 (5) - 2.2696 (98) = - 7.9

$P_3$ (Teacher 3 for Student 10) = -83.9826 - 5.0953 (0) + .7481 (1) +

.5904 (5) + 1.1978 (98) = 37.1

Step 4. Predict Future Performance for Each Student with Each Teacher.

The predicted values (P matrix) for the 42 pupils for each of three teachers are shown in Table 1.

TABLE 1

P-MATRIX: Math, School A

| Pupil | Teacher 1 | Teacher 2 | Teacher 3 |
|---|---|---|---|
| 1 | 87.9 | 49.7 | 15.1 |
| 2 | 73.5 | 64.7 | 66.4 |
| 3 | 71.7 | 88.3 | 63.6 |
| 4 | 36.7 | 55.7 | 74.1 |
| 5 | 50.8 | 84.7 | 69.6 |
| 6 | 50.8 | - 4.7 | 36.4 |
| 7 | 77.3 | 96.3 | 69.5 |
| 8 | 45.7 | 50.6 | 35.9 |
| 9 | 19.9 | 13.8 | 37.5 |
| 10 | 42.6 | - 7.9 | 37.1 |
| 11 | 86.8 | 75.0 | 71.1 |
| 12 | 141.6 | 100.6 | 44.0 |
| 13 | 81.2 | 67.0 | 65.2 |
| 14 | 53.3 | 44.0 | 25.2 |
| 15 | 70.7 | 51.7 | 54.0 |
| 16 | 48.3 | 79.5 | 77.1 |
| 17 | 43.7 | 39.3 | 53.4 |
| 18 | 80.3 | 55.5 | 86.7 |
| 19 | 38.7 | 85.0 | 75.5 |
| 20 | 80.3 | 87.0 | 68.4 |
| 21 | 65.6 | 70.5 | 47.7 |
| 22 | 21.0 | 59.3 | 56.6 |
| 23 | 79.0 | 63.7 | 62.8 |
| 24 | 43.7 | 46.6 | 65.6 |
| 25 | 27.7 | 25.0 | 45.8 |
| 26 | 39.2 | 76.8 | 66.6 |
| 27 | 41.6 | 45.1 | 60.5 |
| 28 | 78.6 | 89.8 | 90.6 |
| 29 | 56.8 | 39.0 | 51.4 |
| 30 | 79.5 | 108.5 | 81.3 |
| 31 | 68.4 | 83.5 | 60.1 |
| 32 | 105.4 | 73.7 | 65.5 |
| 33 | 75.9 | 85.8 | 87.7 |
| 34 | 76.6 | 33.7 | 32.1 |
| 35 | 109.9 | 81.8 | 67.5 |
| 36 | 66.5 | 54.2 | 29.9 |
| 37 | 67.2 | 27.3 | 34.3 |
| 38 | 100.1 | 94.2 | 85.2 |
| 39 | 86.1 | 56.3 | 51.6 |
| 40 | 116.9 | 19.7 | 31.6 |
| 41 | 159.7 | 100.2 | 35.1 |
| 42 | 53.8 | 62.7 | 73.5 |

Step 5. Compute Optimality Index Values.

The row (pupil) mean predicted math performance values, the column (teacher) mean predicted math performance values and the grand mean are used to compute the Optimality Index (D matrix) values shown in Table 2.

TABLE 2

D-MATRIX: Math, School A

| Pupil | Teacher 1 | Teacher 2 | Teacher 3 |
|---|---|---|---|
| 1 | 30.5 | .1 | -30.6 |
| 2 | - 1.1 | - 2.2 | 3.3 |
| 3 | - 9.3 | 15.0 | - 5.7 |
| 4 | -25.3 | 1.5 | 23.8 |
| 5 | -24.0 | 17.6 | 6.4 |
| 7 | -10.2 | 16.5 | - 6.2 |
| 8 | - 4.9 | 7.8 | - 2.9 |
| 9 | -10.3 | - 8.6 | 18.9 |
| 10 | 12.1 | -30.5 | 18.4 |
| 11 | 2.6 | - 1.3 | - 1.3 |
| 12 | 39.6 | 6.5 | -46.1 |
| 13 | 3.6 | - 2.8 | - .7 |
| 14 | 5.9 | 4.4 | -10.4 |
| 15 | 5.4 | - 5.7 | .3 |
| 16 | -26.5 | 12.5 | 13.9 |
| 17 | - 8.2 | - 4.8 | 13.1 |
| 18 | - .3 | -17.3 | 17.7 |
| 19 | -34.1 | 19.8 | 14.3 |
| 20 | - 4.7 | 9.7 | - 4.9 |
| 21 | - 2.2 | 10.5 | - 8.3 |
| 22 | -31.1 | 14.9 | 16.1 |
| 23 | 3.9 | - 3.4 | - .5 |
| 24 | -14.8 | - 4.0 | 18.8 |
| 25 | -11.6 | - 6.5 | 18.1 |
| 26 | -28.1 | 17.2 | 10.9 |
| 27 | -14.0 | - 2.6 | 16.6 |
| 28 | -14.2 | 4.7 | 9.4 |
| 29 | 1.2 | - 8.8 | 7.5 |
| 30 | -16.7 | 19.9 | - 3.2 |
| 31 | - 8.7 | 14.1 | - 5.3 |
| 32 | 17.3 | - 6.5 | -10.7 |
| 33 | -13.7 | 3.9 | 9.7 |
| 34 | 22.6 | -12.4 | -10.1 |
| 35 | 17.0 | - 3.3 | -13.6 |
| 36 | 9.7 | 5.3 | -15.1 |
| 37 | 17.7 | -14.2 | - 3.4 |
| 38 | .4 | 2.3 | - 2.7 |
| 39 | 14.9 | - 7.0 | - 7.8 |
| 40 | 54.3 | -35.0 | -19.2 |
| 41 | 54.8 | 3.1 | -58.0 |
| 42 | -16.0 | .6 | 15.4 |

For Student Number 10 the Optimality Values are as follows:

$D_1$ (Teacher 1 for Student 10) = 42.6 - 23.95 - 69.12 + 62.60 = 12.1

$D_2$ (Teacher 2 for Student 10) = - 7.9 - 23.95 - 61.30 + 62.60 = - 30.5

$D_3$ (Teacher 3 for Student 10) = 37.1 - 23.95 - 57.39 + 62.60 = 18.4

Observe that for Student 10 the highest predicted performance is for Teacher 1; however, the largest optimality value is associated with Teacher 3. This suggests that the assignment of Student 10 to Teacher 3 would tend to maximize the total expected math performance for all 42 students - if 13 students were assigned to each teacher.

Step 6. Determine Proportion of Predicted Performance Variance Due to Pupils, Teachers, and Interaction.

The variance proportions for math are:

| | |
|---|---|
| Pupil Differences | .54 |
| Teacher Differences | .03 |
| Interaction Among Pupils and Teachers | .43 |
| Total | 1.00 |

Step 7. Consider Use of Predicted Performance and Optimality Values.

The interaction proportion (.43) indicates that there might be sufficient pupil-teacher interaction to consider use of the optimality values in matching pupils to teachers. Application of the TPM system to future students is needed to confirm these findings.

School A - Reading

Step 1. Select Teachers and Pupils.

Same as School A - Math teachers and pupils.

Step 2. Collect information.

Same as School A - Math information except

Y = Posttest for SRA reading

D = Pretest for SRA reading

Step 3. Compute Prediction Equations.

The three least-squares prediction equations are:

Teacher 1: (19)

$P_1$ (Predicted Reading Posttest for Teacher 1) = 68.5040 + 3.6435 (B) + .6017 (C) + .5531 (D) - .3790 (E)

$P_2$ (Predicted Reading Posttest for Teacher 2) = -98.6150 + 9.6953 (B) - 5.4673 (C) + .5602 (D) + 1.2656 (E)

$P_3$ (Predicted Reading Posttest for Teacher 3) = 24.2116 - 12.4021 (B) + 3.7022 (C) + .7570 (D) + .0132 (E)

Step 4. Predict Future Performance for Each Pupil with Each Teacher.

The predicted values for reading are presented as Matrix P in Table 3.

TABLE 3 P-MATRIX: Reading, School A

| Pupil | Teacher 1 | Teacher 2 | Teacher 3 |
|---|---|---|---|
| 1 | 62.9 | 45.2 | 45.5 |
| 2 | 61.8 | 51.3 | 65.5 |
| 3 | 52.5 | 46.2 | 35.0 |
| 4 | 46.6 | 44.1 | 47.4 |
| 5 | 79.6 | 78.6 | 73.6 |
| 6 | 52.8 | 39.4 | 57.2 |
| 7 | 68.0 | 61.9 | 56.1 |
| 8 | 44.2 | 37.8 | 23.6 |
| 9 | 52.9 | 47.2 | 55.0 |
| 10 | 61.2 | 49.6 | 69.3 |
| 11 | 83.7 | 71.8 | 95.0 |
| 12 | 54.1 | 31.3 | 31.8 |
| 13 | 46.7 | 34.3 | 44.3 |
| 14 | 70.4 | 61.1 | 58.4 |
| 15 | 43.9 | 31.5 | 40.5 |
| 16 | 79.6 | 75.9 | 92.1 |
| 17 | 36.1 | 28.6 | 31.5 |
| 18 | 64.7 | 54.8 | 74.6 |
| 19 | 87.7 | 90.1 | 85.7 |
| 20 | 57.3 | 54.4 | 42.5 |
| 21 | 44.6 | 36.6 | 23.6 |
| 22 | 66.1 | 68.3 | 56.2 |
| 23 | 51.6 | 39.3 | 51.1 |
| 24 | 42.5 | 40.0 | 27.4 |
| 25 | 60.6 | 55.1 | 65.6 |
| 26 | 78.1 | 78.8 | 72.1 |
| 27 | 64.5 | 59.0 | 70.9 |
| 28 | 56.6 | 49.3 | 59.5 |
| 29 | 37.6 | 30.0 | 19.0 |
| 30 | 77.6 | 73.3 | 69.8 |
| 31 | 38.1 | 31.7 | 15.3 |
| 32 | 69.0 | 55.2 | 59.8 |
| 33 | 84.8 | 77.9 | 98.1 |
| 34 | 67.2 | 50.1 | 70.8 |
| 35 | 78.2 | 61.3 | 85.9 |
| 36 | 64.2 | 53.1 | 49.3 |
| 37 | 37.6 | 25.1 | 17.5 |
| 38 | 87.6 | 75.8 | 100.3 |
| 39 | 71.2 | 55.9 | 76.9 |
| 40 | 61.9 | 35.4 | 65.4 |
| 41 | 93.9 | 66.8 | 84.7 |
| 42 | 64.5 | 59.0 | 70.9 |

Step 5. Compute Optimality Index Values.

The Optimality Index Values for Reading are presented as Matrix D in Table 4.

TABLE 4

D-MATRIX: Reading, School A

| Pupil | Teacher 1 | Teacher 2 | Teacher 3 |
|---|---|---|---|
| 1 | 7.2 | - 1.0 | - 6.1 |
| 2 | - 2.2 | - 3.3 | 5.5 |
| 3 | 3.4 | 6.5 | -10.0 |
| 4 | - 3.9 | 3.0 | .9 |
| 5 | - 1.4 | 4.9 | - 3.4 |
| 6 | - 1.4 | - 5.4 | 6.9 |
| 7 | 1.4 | 4.8 | - 6.3 |
| 8 | 4.5 | 7.5 | -12.0 |
| 9 | - 3.2 | .4 | 2.8 |
| 10 | - 3.2 | - 5.5 | 8.8 |
| 11 | - 4.3 | - 6.7 | 11.0 |
| 12 | 10.5 | - 2.8 | - 7.7 |
| 13 | .4 | - 2.5 | 2.1 |
| 14 | 2.6 | 2.6 | - 5.3 |
| 15 | .7 | - 2.2 | 1.4 |
| 16 | - 7.4 | - 1.6 | 9.1 |
| 17 | - .4 | 1.4 | - 1.0 |
| 18 | - 4.4 | - 5.0 | 9.4 |
| 19 | - 4.6 | 7.1 | - 2.5 |
| 20 | 1.4 | 7.8 | - 9.2 |
| 21 | 5.1 | 6.5 | -11.7 |
| 22 | - 1.9 | 9.6 | - 7.7 |
| 23 | - .2 | - 3.1 | 3.3 |
| 24 | 1.4 | 8.2 | - 9.6 |
| 25 | - 4.2 | - .4 | 4.7 |
| 26 | - 2.7 | 7.3 | - 4.6 |
| 27 | - 4.7 | - .8 | 5.6 |
| 28 | - 3.9 | - .9 | 3.9 |
| 29 | 4.2 | 6.9 | -10.2 |
| 30 | - .4 | 4.6 | - 4.1 |
| 31 | 5.2 | 8.2 | -13.5 |
| 32 | 5.1 | - 1.2 | - 1.9 |
| 33 | - 6.6 | - 4.1 | 10.7 |
| 34 | - 1.2 | - 7.64 | 7.6 |
| 35 | - 1.4 | - 9.9 | 10.3 |
| 36 | 4.1 | 2.4 | - 6.6 |
| 37 | 6.4 | 3.2 | - 9.7 |
| 38 | - 4.7 | - 7.2 | 12.0 |
| 39 | - 1.2 | - 7.1 | 8.4 |
| 40 | 3.1 | -13.9 | 10.7 |
| 41 | 7.6 | -10.1 | 2.4 |
| 42 | - 4.7 | - .8 | 5.6 |

Step 6. Determine Proportion of Predicted Performance Variance Due to Pupils, Teachers, and Interaction.

The variance proportions for Reading are:

| | |
|---|---|
| Pupil Differences | .85 |
| Teacher Differences | .04 |
| Interaction Among Pupils and Teachers | .11 |
| Total | 1.00 |

Step 7. Consider Use of Predicted Performance and Optimality Values.

The interaction proportion (.11) indicates that there is little to be gained for reading performance by matching the "right" teacher with the "right" pupil.

School B - Reading

Step 1. Select Teachers and Pupils.

Data was collected from 59 third graders, each of whom was taught by one of three teachers from School B.

Step 2. Collect Information.

For each of the 59 third graders, the following information was collected:

Y: Posttest, SAT Achievement Test for Reading, Primary II Level obtained near the end of completion of third grade; reported as standard scores.

A: Pretest, SAT Achievement Test for Reading, Primary I Level obtained near the end of second grade; reported as standard scores.

B: Sex Category of pupil (male or female, treated as binary information).

C: Ethnic Category of Student (Anglo or other treated as binary information).

D and F: Reading Rating by second grade teacher prior to beginning instruction by third grade teacher (Low, Medium, or High; treated as three binary categories).

T: Teacher Identification (1, 2, or 3).

Step 3. Compute Prediction Equations.

The three least-squares prediction equations are:

$P_1$ (Predicted Reading Posttest for Teacher 1) = 70.4172 + .5300 (A) - .6698 (B) + .4198 (C) - 6.5210 (D) + 6.5675 (F)

$P_2$ (Predicted Reading Posttest for Teacher 2) = 94.5609 + .3684 (A) - 1.336 (B) + 5.7749 (C) - 15.4627 (D) - .3147 (F)

$P_3$ (Predicted Reading Posttest for Teacher 3) = 17.6399 + .9169 (A) + 3.2089 (B) - 1.0895 (C) + .6367 (D) + 1.4893 (F)

Where A = Reading Pretest Achievement

B = 1 if pupil is Male, 0 otherwise

C = 1 if pupil is Anglo, 0 otherwise

D = 1 if Reading Rating is Low, 0 otherwise

F = 1 if Reading Rating is Medium, 0 otherwise

For Student Number 1, the predicted Reading Achievement Scores are as follows:

Student Number 1 has a Reading Pretest Score of 128 (A = 128), is a Male (B = 1), is not Anglo (C = 0), and has a Reading Rating of Medium (D=0, F=1).

$P_1$ (Teacher 1 for Student 1) = 70.4172 + .5300 (128) - .6698 (1) + .4198 (0) - 6.5210 (0) + 6.5675 (1) = 144.2

$P_2$ (Teacher 2 for Student 1) = 94.5609 + .3684 (128) - 1.336 (1) + 5.7749 (0) - 15.4627 (0) - .3147 (1) = 140.1

$P_3$ (Teacher 3 for Student 1) = 17.6399 + .9169 (128) + 3.2089 (1) - 1.0895 (0) + .6367 (0) + 1.4893 (1) = 139.70

Step. 4 Predict Future Performance for Each Student with Each Teacher.

The predicted values (P Matrix) for the 59 pupils for each of the three teachers are shown in Table 5.

Step. 5. Compute Optimality Index Values.

The Optimality Index Values for School B Reading are presented as Matrix D in Table 6.

TABLE 5

P-MATRIX: Reading, School B

| Pupil | Teacher 1 | Teacher 2 | Teacher 3 |
|---|---|---|---|
| 1 | 144.2 | 140.1 | 139.7 |
| 2 | 166.8 | 161.6 | 184.5 |
| 3 | 153.6 | 146.7 | 156.2 |
| 4 | 158.0 | 150.6 | 159.4 |
| 5 | 150.5 | 144.4 | 150.7 |
| 6 | 150.5 | 144.4 | 150.7 |
| 7 | 154.1 | 152.4 | 155.1 |
| 8 | 153.6 | 146.7 | 156.2 |
| 9 | 140.9 | 143.5 | 139.5 |
| 10 | 150.1 | 145.0 | 145.6 |
| 11 | 126.9 | 122.9 | 127.3 |
| 12 | 124.1 | 120.1 | 126.9 |
| 13 | 158.0 | 150.6 | 159.4 |
| 14 | 157.4 | 149.2 | 162.6 |
| 15 | 147.3 | 142.2 | 145.2 |
| 16 | 128.9 | 123.4 | 135.1 |
| 17 | 149.4 | 143.7 | 148.8 |
| 18 | 154.1 | 152.4 | 155.1 |
| 19 | 146.2 | 147.2 | 148.7 |
| 20 | 154.7 | 153.8 | 151.9 |
| 21 | 158.9 | 150.6 | 159.4 |
| 22 | 128.9 | 123.4 | 135.1 |
| 23 | 125.7 | 121.2 | 129.6 |
| 24 | 147.9 | 149.0 | 139.9 |
| 25 | 154.7 | 153.8 | 151.9 |
| 26 | 121.6 | 119.2 | 118.2 |
| 27 | 142.0 | 138.5 | 136.0 |
| 28 | 140.5 | 139.4 | 129.1 |
| 29 | 159.3 | 161.8 | 169.6 |
| 30 | 164.8 | 154.4 | 175.4 |
| 31 | 151.1 | 145.8 | 147.4 |
| 32 | 158.9 | 156.0 | 170.7 |
| 33 | 126.7 | 127.3 | 129.5 |
| 34 | 146.8 | 141.9 | 144.2 |
| 35 | 128.0 | 123.6 | 129.2 |
| 36 | 124.7 | 120.5 | 127.8 |
| 37 | 150.1 | 145.0 | 145.6 |
| 38 | 142.7 | 139.9 | 132.8 |
| 39 | 130.4 | 129.9 | 135.9 |
| 40 | 122.7 | 119.9 | 120.0 |
| 41 | 123.6 | 119.7 | 126.0 |
| 42 | 125.1 | 126.2 | 126.7 |
| 43 | 125.2 | 127.2 | 122.6 |
| 44 | 126.3 | 121.6 | 130.6 |
| 45 | 146.3 | 141.8 | 144.2 |
| 46 | 166.8 | 161.6 | 184.5 |
| 47 | 125.2 | 120.8 | 128.7 |
| 48 | 129.6 | 124.7 | 131.9 |
| 49 | 158.9 | 156.0 | 170.7 |
| 50 | 151.5 | 150.9 | 157.9 |
| 51 | 143.9 | 144.8 | 149.2 |
| 52 | 132.6 | 126.0 | 141.6 |
| 53 | 118.3 | 116.0 | 116.8 |
| 54 | 147.8 | 148.3 | 151.5 |
| 55 | 129.0 | 124.4 | 131.0 |
| 56 | 143.1 | 145.7 | 131.7 |
| 57 | 143.5 | 145.4 | 144.1 |
| 58 | 124.8 | 121.4 | 123.7 |
| 59 | 148.4 | 149.3 | 149.9 |

TABLE 6

D-MATRIX; Reading, School B

| Pupil | Teacher 1 | Teacher 2 | Teacher 3 |
|---|---|---|---|
| 1 | 2.1 | 1.3 | - 3.5 |
| 2 | - 4.7 | - 6.7 | 11.5 |
| 3 | .8 | - 2.9 | 2.0 |
| 4 | 1.3 | - 2.8 | 1.4 |
| 5 | 1.2 | - 1.4 | .2 |
| 6 | 1.2 | - 1.4 | .2 |
| 7 | - .4 | 1.1 | - .7 |
| 8 | .8 | - 2.9 | 2.0 |
| 9 | - 1.1 | 4.8 | - 3.6 |
| 10 | 2.5 | .7 | - 3.2 |
| 11 | .5 | - .2 | - .3 |
| 12 | - .2 | - 1.0 | 1.2 |
| 13 | 1.3 | - 2.8 | 1.4 |
| 14 | .3 | - 4.5 | 4.2 |
| 15 | 1.7 | - 6.7 | - 1.6 |
| 16 | - .9 | - 3.1 | 4.0 |
| 17 | 1.4 | - 1.0 | - .4 |
| 18 | - .4 | 1.1 | - .7 |
| 19 | - 1.8 | 2.4 | - .5 |
| 20 | .6 | 2.9 | - 3.5 |
| 21 | 1.3 | - 2.8 | 1.4 |
| 22 | - .9 | - 3.1 | 4.0 |
| 23 | - .4 | - 1.7 | 2.1 |
| 24 | 1.5 | 5.9 | - 7.5 |
| 25 | .6 | 2.9 | - 3.5 |
| 26 | 1.2 | 2.1 | - 3.4 |
| 27 | 2.4 | 2.2 | - 4.7 |
| 28 | 3.8 | 4.9 | - 8.8 |
| 29 | - 4.9 | .8 | 4.1 |
| 30 | - .7 | - 7.8 | 8.6 |
| 31 | 2.3 | .2 | - 2.6 |
| 32 | - 3.6 | - 3.2 | 6.8 |
| 33 | - 1.8 | 2.1 | - .2 |
| 34 | 1.8 | .1 | - 1.9 |
| 35 | .3 | - .7 | .3 |
| 36 | - .3 | - 1.2 | 1.5 |
| 37 | 2.5 | .7 | - 3.2 |
| 38 | 3.5 | 4.0 | - 7.5 |
| 39 | - 2.3 | .4 | 1.8 |
| 40 | 1.1 | 1.6 | - 2.8 |
| 41 | - .1 | - .7 | .9 |
| 42 | - 1.5 | 2.8 | - 1.2 |
| 43 | - .4 | 4.7 | - 4.3 |
| 44 | - .5 | - 1.9 | 2.4 |
| 45 | 1.8 | .1 | - 1.9 |
| 46 | - 4.7 | - 6.7 | 11.5 |
| 47 | - .3 | - 1.4 | 1.8 |
| 48 | .1 | - 1.4 | 1.2 |
| 49 | - 3.6 | - 3.2 | 6.9 |
| 50 | - 2.6 | 6.7 | 2.5 |
| 51 | - 2.7 | 1.5 | 1.2 |
| 52 | - 1.4 | - 4.8 | 6.2 |
| 53 | .5 | 1.5 | - 2.1 |
| 54 | - 2.0 | 1.7 | .3 |
| 55 | .2 | - 1.1 | .9 |
| 56 | 2.2 | 8.1 | -10.3 |
| 57 | - 1.4 | 3.6 | - 2.1 |
| 58 | .8 | .7 | - 1.5 |
| 59 | 1.5 | 5.7 | - 7.2 |

Step 6. Determine Proportion of Predicted Performance Variance Due to Pupils, Teachers, and Interaction.

The variance proportions for School B Reading are:

| | |
|---|---|
| Pupil Differences | .93 |
| Teacher Differences | .02 |
| Interaction Among Pupils and Teachers | .05 |
| Total | 1.00 |

Step 7. Use of Predicted Performance and Optimality Values.

The interaction proportion (.05) indicates that there is little to be gained for future School B Reading performance by matching pupils to these three teachers.

## Discussion

The purpose of this project was to demonstrate some procedures that can be used to supply information that can help match pupils to teachers to maximize learning outcomes. While the objective was to demonstrate a procedure, the results of the application of the procedure proved to be quite interesting.

The results revealed that for School A matching teachers to second grade pupils might make a difference in total mathematics achievement. However, for the same three teachers in School A, reading performance probably would not be improved by making good teacher-pupil matches. Also, for the third graders from School B, reading performance probably would not be improved much by making good matches.

Use of the procedure will allow educators to estimate the potential effect of focusing on teacher-pupil match. The analysis will give an indication of the extent of teacher-pupil match effects; however, the results should be applied to new pupils to gain confidence in the results.

## Future Research

The computer procedures should be packaged so that they can be executed on any of the small computers available to schools. Easy availability of these techniques for optimally assigning pupils to teacher will allow educators to determine when, for which subjects, and under what conditions, it is important to be concerned with teacher-pupil match.

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